"JOURNAL OF THE CONSTRUCTORS CLUB"

Hot Iron

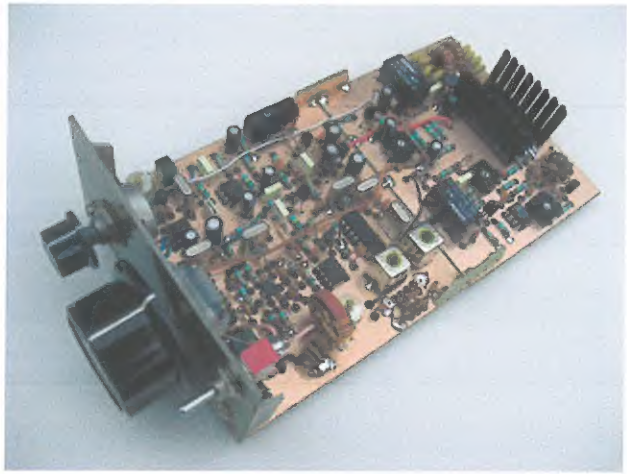
Spring 2011
Issue 75

Contents

The Walford Electronics website is also at www.walfordelectronics.co.uk

Editorial

The extremely cold WX has just finished and I ought really to be outside doing some farming but need to get started on Hot Iron! Continuing with my theme of VFO matters in my last editorial, further testing and observation over a long time showed that although it (the Bridgwater's VFO) was basically stable, and was not running gently out of the band, it was not really useable due to short term wandering both up and down in frequency. Not really believing that this was likely to be due to the inductor changing value that quickly because of its greater thermal mass, it had to be the resonating capacitor (only one at this stage) that was suspect! Experiments with other types soon showed this to be correct! They cured the short term wandering but not the long term drift! I had to find some N150 types (-150 ppm/°C temperature coefficient) that did not exhibit the short term wandering effects! Years ago I had two sorts of round N150 ceramic discs (about 5 mm across with an orange flash) that were good but my stock is now effectively exhausted and no longer obtainable. I considered silver mica and polystyrene types (but they don't really have the right tempco) and they are fiendishly expensive at not less than £1 each in quantity. After much searching, I found that Anglia Components had some non compliant old stock of 150 pF ceramic N150 types. I bought a thousand and they proved excellent, so I have now bought the rest of their stock - enough to keep me and any successors in this business for a century! In future all my VFOs will use only 150 pF parts!! My latest tests on the small pale yellow rectangular ceramic plate types showed them to be poor - they are slightly smaller than they used to be and I suspect have a different dielectric that is not N150. If doing your own VFO work, beware that different types do have markedly different performance! Tim G3PCJ.



Kit Developments

The **Bridgwater** and **Burnham** (right) are now ready for release - 1.5W SSB on any single band 20 to 80m. An early one is happily driving a Linear on 20m. The normal price for RX and TX will be £83.

My most recent thoughts have been about a new rig christened the **Burtle**. Specialist 1.5W CW TCVR for any single band 10 to 160m if all goes according to plan. Full VFO + xtal mixing. £50 ish! Tim

Hot Iron is a quarterly subscription newsletter for members of the Construction Club. Membership costs £7 per year with the first issue for each year appearing in September. Those people joining later in the year will be sent the earlier issues for that year. Membership is open to all and articles or questions or comments or notes about any aspect of electronics—principally on amateur radio related topics– is very welcome. Notes on member's experience building their own gear, from kits or otherwise is most interesting to other constructors. To keep it interesting, your thoughts and ideas are required please! For membership, I only need your name and address and subscription. Send it or any other suggestions to Tim Walford, Walford Electronics, Upton Bridge Farm, Long Sutton, Langport, Somerset TA10 9NJ © G3PCJ

Testing Transistors and Class C amplifiers by Peter Thornton G6NGR

No doubt many of you have tested a transistor with a multi-meter, and are completely familiar with the 'two diodes' idea, but here is a different approach.

We all know the scenario; yes, I measure two diodes with a common connection at the base lead. But which is the collector and which the emitter? A simple multi-meter 'ohms' test cannot distinguish between them.

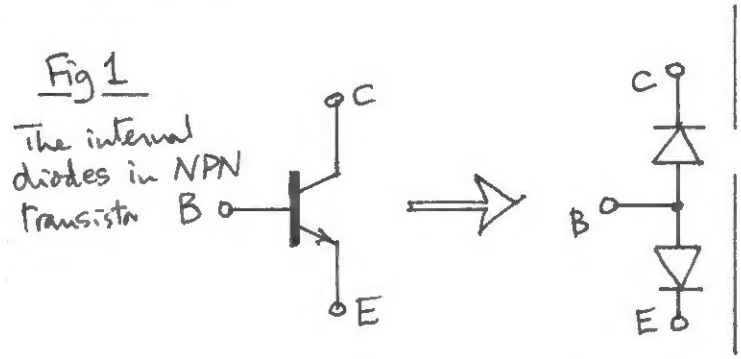
Here is a little gem that will help. The collector to base diode ahs to withstand large voltages when the transistor is off; its this high voltage ability that gives the bipolar its power handling capabilities. Not so the base to emitter junction however. The base to emitter diode is very heavily doped to inject carriers into the collector region to turn 'on' the transistor when a base to emitter current is fed in. In fact it is so heavily doped that it acts as a *Zener diode* when reversed biased - see Fig 1.

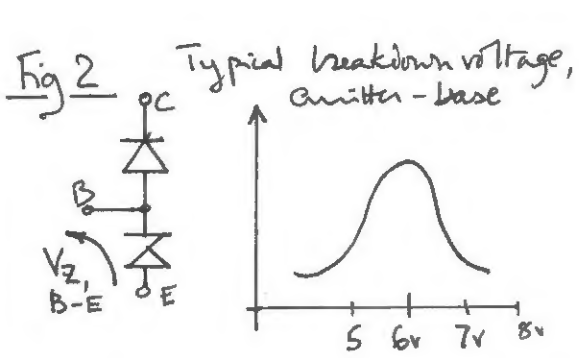
Fig 2 shows the typical spread of voltages that you will find - 6 volts or so is typical. That's the reason your multi-meter will not find these Zeners because it uses a low(ish) voltage for ohms testing, even on the diode range of super whiz band modern meter. Its back to back to basics and some old fashioned test gear - a test lamp!

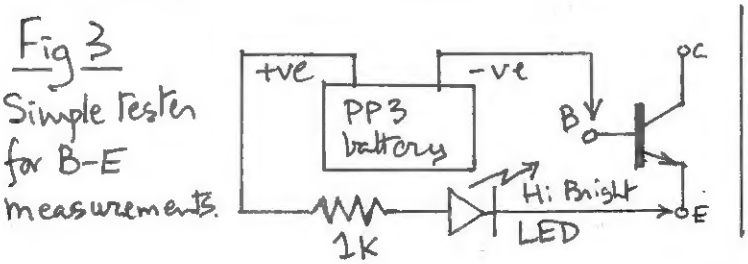
The way to differentiate collector and emitter is to see which junction will break over with a bias of say 9 volts dc; easily obtained from a PP9 9 volt battery. You will need a resistor in series with the battery to limit the current - see Fig 3. The high brightness LED needs only a sniff of current top light, so when testing the emitter to base junction (reverse bias, the emitter to the positive lead, base to negative lead) will light the LED dimly. The other way round and the LED will be very bright and you will soon own a flat battery!

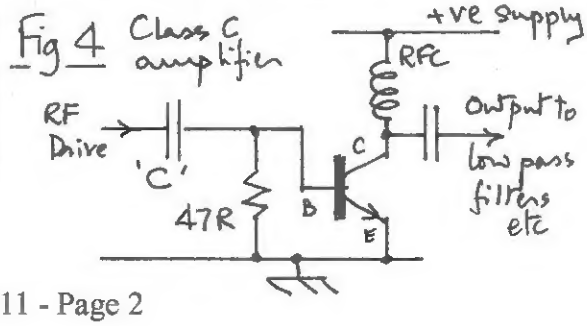
Now lets consider the Class C amplifier. The typical circuit (Fig 4) has the base grounded via a low value resistor, often about 47R, with the drive applied via a capacitor to the base. On the positive half cycle of the drive all is well; the drive pushes the current through the base and emitter to earth and through the 47R resistor in parallel. The 47R is selected to ensure that on negative half cycles the drive never applies more than –6v to the emitter. If the emitter base diode is driven into Zener breakdown do not expect your final stage device to last very long!

As ever the 47R resistor is a compromise - increase it and you get more drive and more output, but don't go too high or the emitter-base diode will Zener on the negative halve cycles and you can watch that final plop its clogs!









Peter Thornton G4NGR

Valves Revisited by Craig G0HDJ

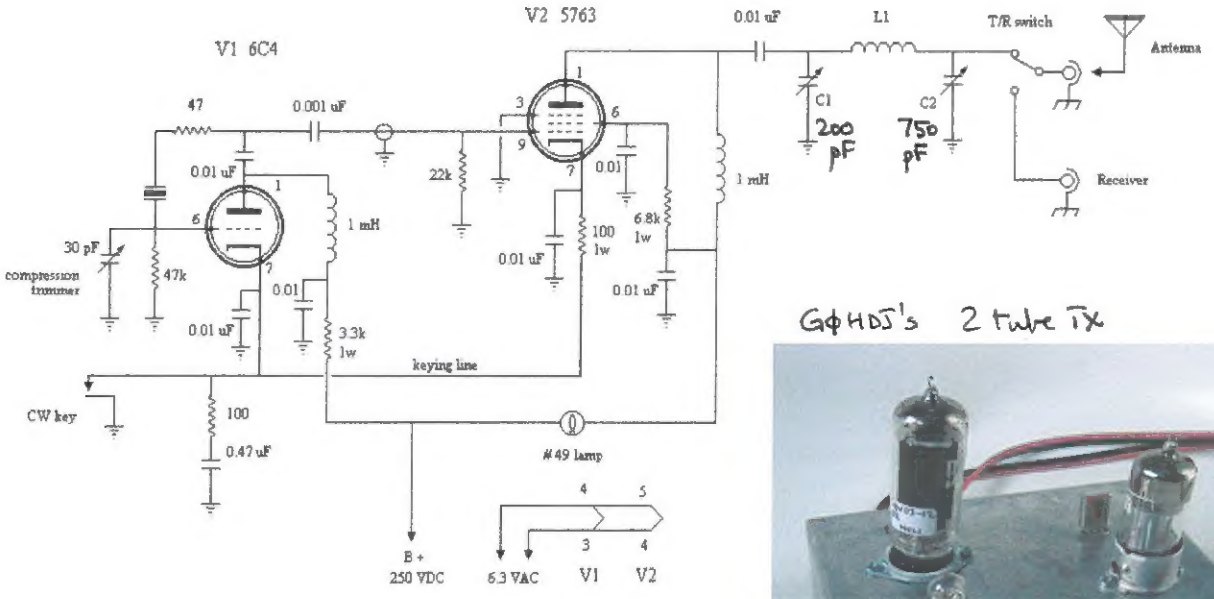
For a change of diet I thought I would try some valve based equipment construction. I have had moderate success with the building of 1 or 2 valve MF and SW receivers. There is also the necessary multiple PP3 battery box for HT and the 240V/6.3V LT supply. So I thought a simple crystal controlled transmitter was the next challenge. But for me this was a different ball game and 'Plate Loading' turned out to have a new meaning! (It is what I normally do with my wife's cooking). A steep learning curve was undertaken – difficult when your brain is fossilizing. Eventually I managed to build something that sort of works. A few facts I discovered:-

- Old books like the 1951 'The Radio Handbook' are better replaced by the likes of the RSGB 'Valves Revisited'.
- Not all valve circuits found on the internet are necessarily reproducible or work according to the author's write-up.
- Geoff Davis (Radio) is a good source of valves but not always the ones you may need.
- Valves off the internet are nearly always from USA, Russia or Hong Kong.
- Valve equivalents are not necessarily so.
- There are no local radio shops that test valves.
- High voltage non-active parts are available from some suppliers but sources are getting fewer.
- Tag strips replace PCB's.
- 'Old junk' stalls at radio rallies may require some investigation.

All is great fun and keeps the soldering iron hot. I tried two projects:

- Simple one 'tube' CW TX by WA2NTK using the power pentode valve 6AQ5 output about 0.5W (author claims 7W!)
- 'Two Tube Tuna Tin Transmitter (5T)' by WD8DAS using triode 6C4 as an oscillator and power pentode 5763 as pa. Output about 1.3W (author claims 8W!)

I would be grateful for any advice/suggestions/thoughts re the power output variance. (In words of one syllable or less and on the back of a post card!!) The circuit of the WD8DAS Two tube Tuna tin TX and my version are shown below. Craig G0HDJ



L1 32 turns @ 16 tpi
2" long on 1" dia former

G0HDJ's 2 tube TX

Fun in Far Flung Places by Dave Buddery Jnr

A few years have passed, I had changed employer and moved along in my career. The new company where I had been working for 2 years was doing a lot of work in a certain Middle East country with the likelihood of a lot more and it needs to modernise its ways. I was at the time very busy in the UK office, supporting local and international operations when one morning, the USA-based International division MD walks into my workshop area. "Dave," he says, "We need to go for lunch today, can you be ready for 1200?" "Yes", I replied, wondering what this was about. At about 1200 he came and picked me up, we went off to a good pub restaurant and a quiet table in an alcove with the UK MD and the group chief engineer there too. I knew this was way out of the ordinary and wondered even more what it was all about.

There was not a lot of time wasted, "Dave", he says, "You know there is a large amount of work going on down 'there'?" "Sure," I replied, "I've been down there for start-ups and I know about most of the current activity." He looked at me and said, "OK good, but we are looking at a big expansion down there plus upgrades of all the existing operations." The former I did know but the latter I didn't know right then, but I wasn't surprised. He went on, "We have looked at our personnel list worldwide and considered hiring but we have figured out that you are first choice for the main technical support job. Will you go please?" I WAS surprised but delighted too, nothing like this had been on the radar screen. "Yes," I said, never being one to hesitate, "I'll go." There was a look of relief all round - we had a very good and rather liquid lunch.

I knew there was amateur radio down there and looked up the local radio club details. I wrote the secretary a letter letting him know that I was coming out and asking what the gen was about shipping gear out, getting licensed etc. He telexed me back [before the days of the internet and e-mail] and warned me not to carry or ship any gear without getting a license first or it would be confiscated. Accordingly I boxed-up my UK station and resolved to get moving on formalities on arrival.

About 3 weeks later I had flown out and was sitting in the local head office, being checked out by the local MD. He had been going through my CV, which at my level in the Company on transfer was sent to the local MD and then he said, "You say here you know about radios, you are a Radio Amateur, is that any use to us?" I was amazed! I knew of course we used HF communications to keep in touch with field operations and that UHF and VHF were de rigueur on all the operations, in fact we could not operate without all that. I replied, "You know that without HF you can't talk from here to the field operations and that most ops have around 60 to 100 VHF and UHF units without which you can't operate. These keep running at least in part because you have a number of amateur radio enthusiasts in the workforce who do it as a side line?" This was absolutely true; radio maintenance wasn't catered-for as a listed job skill. His jaw dropped and I could see he didn't know what to say. I had him cold. Anyway, he calmed down and eventually replied "OK, OK, but did you know that we are out to tender for an operation in the mountainous area in the east here and we are quoting to use a radio telemetry system?" That I didn't know because the individual offices of decent size worked as semi-autonomous units in an independent and competitive manner within the company (a management technique ahead of its time in those days). "No," I said truthfully, "That news hadn't arrived at my level in London." "OK, you had better get up to speed with the tender but it will be at least 6 months before we start because there will be a lot of work to be done to prepare for it". "For certain," I said, "No doubt there will be a huge amount to do with approvals, licencing etc." His eyebrows shot up when I said the word "licencing". I thought, "What's up now?" He said nothing for a minute then looked at me and said "How about a beer tonight at your hotel?" "Yes, that's a good idea," I replied. We finished the interview and I went off to the operations office and got out the tender for the radio telemetry system and all its accompanying documents. I spent a couple of hours going through it and talking to the local operations guys. It was so far in the future they hadn't really got much into it at the time.

Finally I went back the hotel and waited for the evening meeting. I had been in the place a few days and had put my toe into the water regarding getting an amateur radio license which was off to a fair start. The local MD arrived as agreed and we had a beer in a quiet part of the bar. To paraphrase, "Dave, we got a problem," he said. I replied, "Tell me please." He looked around, probably to make sure no-one was listening and said, "We haven't paid any of our radio license fees for 2 years and year 3 is coming up. Please think about what we might do about it, I'm open to suggestions. I could try to fix it on my own but I need some help regarding the paperwork, "transmission modes" etc., I'm just not into that." Continued on next page.....

Fun in Far Flung Places continued>

We talked about a few more things affecting the matter but I was horrified and began to think quickly about how we got into the jam, it might show me the way out of the situation. I asked, "What happened before the problem started, who looked after it in the more distant past while it was being paid?" He sank his pride a long way and said "We had a guy like you out here and he filled up the paperwork and the accountant submitted it." I carried on, "Well, how did it take nearly 3 years before we figured we had a problem?" (Makes you think doesn't it?) I could see him visibly stiffen, then he replied, "The accountant asked why certain regular payments had stopped, we looked into all of them and of course it came to light. Otherwise, it would probably have gone unnoticed." I thought about the Ministry responsible for radio licensing and wondered why they had not come after the company and asked the question. He replied that he thought they were pretty inefficient and just relied on companies like ours doing the right thing. I moved around the edges a bit more and asked why we could not carry on in a like manner. The MD looked in his brief case and pulled out a clipping from the local Government "Gazette" newspaper. It was a recent warning to companies to make sure their radio licensing formalities were up to date as they could be subject to inspection and audit etc. The game was up, we had to fix it. If we got found out and they closed down all our radio systems we would be totally unable to work – a disaster. The MD went home not long after and I went for a walk to think about things. I had a small entertainment budget as part of the job and resolved to call the secretary of the local radio club and to spend a bit of it sounding him out, I didn't yet have any contacts with local radio licensing experience [apart from the MD!]. I was very worried too about "guilt by association", because if my company got found out before things were rectified, bang would go my hopes of an amateur radio license.

So a couple of nights later I invited the radio club secretary out for a meal and over it I told him all about this mythical company which had not paid radio license fees etc. etc. He smiled and said, "You will need to offer them three times the unpaid frees if you don't want real bad problems." Fair enough I thought, and wise in the ways of indifferent management, I went to work and told my MD that four times the unpaid fee was the going rate. He argued, so very, very reluctantly (to his face) and after some argument, I agreed that we would open the batting at three times the unpaid fee, mentally keeping my fingers crossed. To cut this short, it worked. I filled out the paperwork (designed for licensing a radar or satellite communications system – I imagine it had been copied out by a clerk from the sub-continent and then generally applied, but I'm used to that sort of thing, fortunately). We went to the ministry, the MD did the talking, after all he had got us into the jam. They were pleased with three times the fee, I think it came out close to the equivalent of £100,000 if my memory serves me well.

The moral of this story is – amateur radio to the rescue again and the MD of course, never knew about the radio club secretary. I eventually got a bit of recognition for having sorted out the problem.

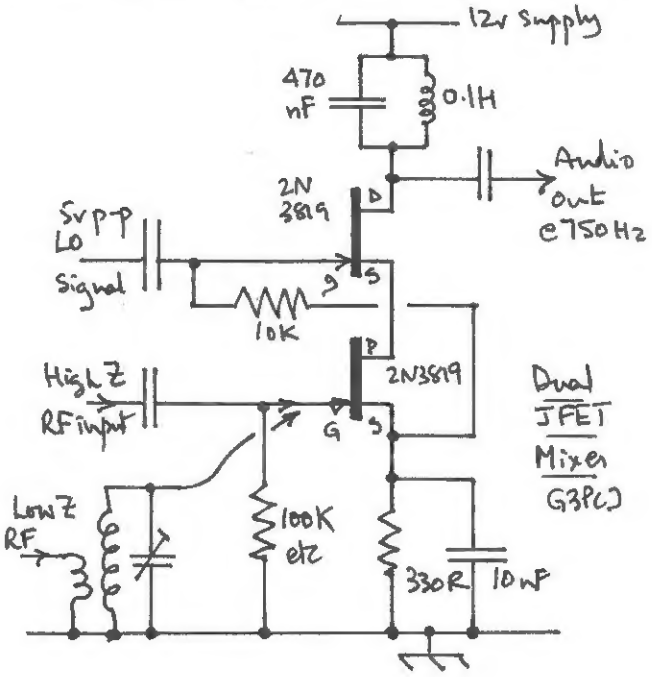
Bath Buildathon winner

Nothing to do with the above but Zoe Thomas (right) M6ZOE did her famous project (a Tone 20m special) which won the RADARC Constructors' Trophy. Well done Zoe!

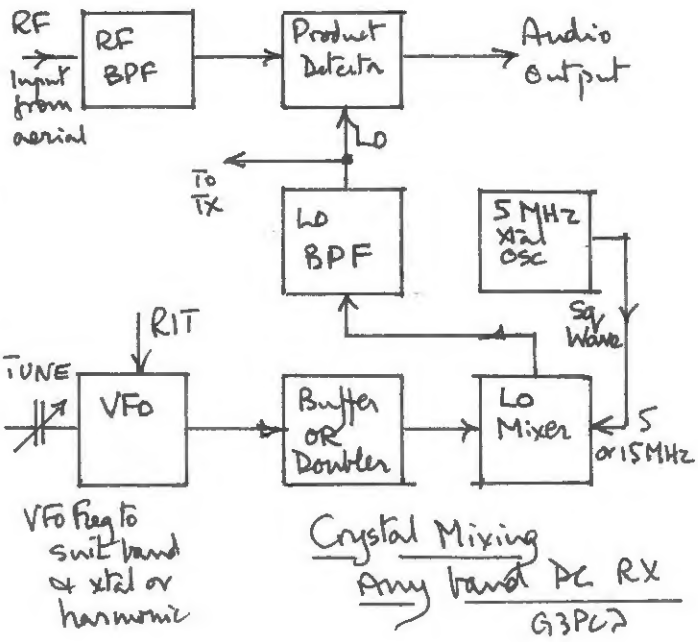
Jottings from my notebook!

The two topics that I mentioned last time, have stimulated a few subsequent scribbles and experiments. Firstly - alternative mixer approaches or devices.

Doubly balanced quad diode mixers have a big attraction - high signal handling ability - but do have a number of significant drawbacks. They are either expensive to buy readymade at near £6 each, or are fiddle-some to make - needing two tri-filar transformers, which often lead to indifferent performance; they also need high LO drive levels at 10 dBm or more. Something made me consider the dual gate MOSFET approach that used to be popular when these devices (40673 etc) were readily available; but they can however be made up by using two ordinary JFETs such as the 2N3819 in series. Both RF (lower) and LO (upper) gates are high impedance points and signal conversion gain is possible with high impedance drain loads at the desired output frequency; this is in addition to any voltage step up that might be possible from a 50R source to the high impedance RF gate. Experiments soon showed that a conversion voltage gain of about x2-3 is feasible with a LO drive of about 5 volts p-p biased at about 1 v DC. At the time I was thinking of a CW DC RX with a drain load resonant at 750 Hz formed by 0.1H with 470 nF as shown right. This agreed well with notes from bygone ARRL publications! A 5v p-p LO signal might easily come from a CMOS digital driving gate producing square waves - it turns out (as might be expected) that its response from the LO odd harmonics is also viable; with the third giving a RF signal conversion voltage gain of about x0.8.



This triggered the second doodling topic! Could this property of useful responses from the fundamental and third harmonic of the LO be used in a crystal mixing rig intended for use on any single band - builder's choice from 160 to 10m? Transmitters using the same frequency for a VFO and the RF output stage are notoriously difficult to stop chirping, especially when getting beyond the useable range of ceramic resonators; hence the necessity of a crystal mixing scheme for a decent rig with VFO that can cover the higher HF bands. This also help considerably with frequency stability! It turns out that a 5 MHz crystal mixed with a VFO set appropriately in the range 3.8 to 6.5 MHz (with buffer/doubler) can do all bands 160 to 10m for a DC rig! You could also do it with a 6 MHz crystal but then 17m is troublesome! Bands below 15m would use the 5 MHz signal; 15m and up would use the 15 MHz third harmonic mixed with the VFO. The rough outline of a possible mixer and LO chain is shown right. Obviously, with such a wide frequency range, it is not practical to use a single type of ready wound TOKO inductor so it would have to have toroids and trimmers for all resonators. Give the rig full break in and narrow CW filters and it begins to look interesting! I have named it the **Burtle** provisionally! I might even start laying out the PCB soon later today! Tim G3PCJ (Done & etched - it ***is*** a tight PCB!)



The Oscilloscope Probe by David Proctor G0UTF

Oscilloscopes are wonderful test instruments as they can measure time (and hence frequency), P.D. both D.C. and A.C, and a double beam scope can measure relative phase of two similar frequency signals.

Of course, the range of HF frequencies is limited by the scope itself, but more often by the input impedance of the scope. This will be typically 1 MOhm in parallel with about 30pF – furthermore the test lead may add another 30pF in parallel.

To decrease the input capacitance we can use a "probe", which is an R & C in parallel, in series with the input of the scope. It is not just any old R & C: they are calculated for a particular scope.

This is how it works:-

Z_p = probe impedance V_s = scope input PD
Z_{in} = input impedance V_{in} = input PD
Z_s = scope impedance C_s = capacitance of scope

$V_s/V_{in} = Z_s/(Z_p+Z_s) = 1/K$ (K = attenuation)

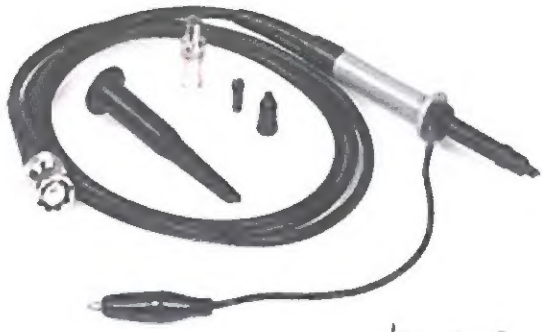
Which gives $Z_p = (K - 1)Z_s$

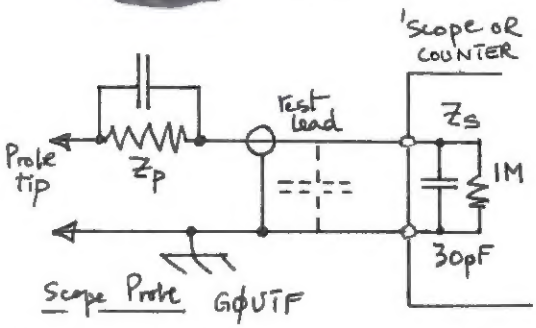
So, the probe input impedance = $Z_{in} = Z_p + Z_s$

$Z_{in} = (K - 1)Z_s + Z_s$

$Z_{in} = KZ_s$

The purpose of the probe is to make Z_{in} much greater than Z_s so K must be high, which means that the input impedance rises by K times but the overall gain is down by a factor of K (don't panic – scopes usually have lots of gain).





QUESTION:- A scope with input resistance 1 MOhm and 30pF is fed by a probe whose cable has 30pF capacitance. You need a voltage reduction factor of 10 at all frequencies. Find the value of the probe resistor and capacitor

ANSWER:- Consider DC only, R_p = 9 MOhm (9 times scope resistance).

Now considering AC: the phase angle of the scope must be the same as the phase angle of the probe. C_p = 6.7pF (one ninth of the scope capacitance)

You could build the probe with a higher attenuation and lower the input capacitance even further, increasing the RF response and increasing the attenuation.

I hope you get the gist of the design – a full treatment is a bit too mathematical.

Comment by G3PCJ - David rightly mentions the capacitance of a typical length of coax used as the connection lead - often 30 pF or more. So if this were to be used without the attenuator at the tip or test point end, it would add 30 pF directly in parallel to the circuit at the point being investigated. Whether the test is being done with a scope or a counter, the effect can be very 'disturbing'! Imagine trying to read the frequency of a relatively high frequency VFO with a counter and then adding 30 pF to the resonating capacitors - the frequency will show appreciably lower than without the probe! It is actually much better to just use a single plain piece of short wire direct to the instrument input socket if you don't have a divide by 10 probe! G3PCJ

Snippets!

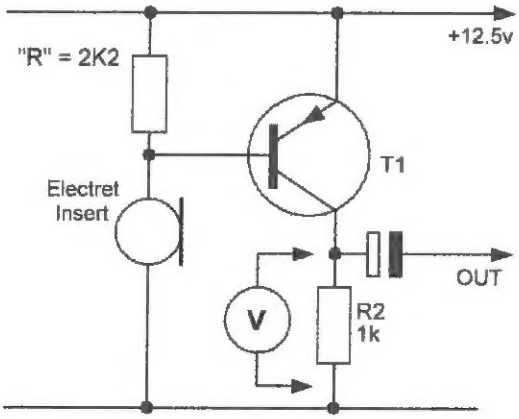
Old Age ICs! Two of the most famous chips are now over 30 years old and still going strong!

The 741 op-amp was designed by Dave Fullager when he was working for Fairchild Semiconductors in 1967. It was the bed-rock of analogue signal processing for more than a decade. It gained a huge following because of its inclusion of parts that made it unconditionally stable in most of the common configurations. Previously Dave had worked for Ferranti in Edinburgh for a couple of years. Dave went on to found Maxim Integrated Products in 1983 and retired in 1999.

The 555 timer chip was designed a little later by Hans Camenzind while working for Signetics which later became part of the Phillips empire now known as NXP. This chip (his 10th design) could also be used in a host of applications where timing was an element. Hans went on to design several chips - among them being the Intersil 8038 waveform generator. He too started his own company Iterdesign which he eventually sold to Ferranti in 1978. By the mid 1990s he had done 135 designs.

Electret speech amp

Recently I think one of our members asked about electret mic amps and I was a bit unsure of my info! But Peter Thornton has kindly sent this circuit on the right along - hope the relevant person is reading this - I have no record of who he was! I think I recall Peter suggesting that R needed a little trial and error adjustment in order to get a few volts across the output 1K R2, and that one might start with a value for R of about 2K2.



KISS ELECTRET PRE-AMP G6NGR

QRP in the Country 2012

I trust you all have **July 15th 2012** entered into your diaries for a visit here - TA10 9NJ in Somerset! Construction Club members are especially welcome. If anybody coming from afar would like help with accommodation overnight let me know.

I already have quite a few stalls booked by local clubs but there is loads of space more for either Club or individual stalls. Provided its broadly related to radio, then its likely to be very suitable; please do encourage your local club to put on something - don't forget that if you all assume somebody else will be doing it, there will not be anything to see. No entry fees to worry about either! If you have any other ideas or suggestions for things that would be of interest then please do let me know. Lets hope we can be outside this time!

As mentioned last time Steve Hartley G0FUW has kindly agreed to consider the entries for an informal **Construction Challenge**. The task is to build a receiver for any MF or HF amateur band using no more than 10 discrete components and if you wish to, also one integrated circuit and one supply regulator. Your choice of types! So this should make it possible to provide a quite useful RX! I will be putting out a national press release soon but Construction Club members have advance warning! Get thinking! Steve will set his own judgement criteria but expect consideration of the three S's - sensitivity, selectivity and stability. A long wire aerial or signal generator will be available for assessment with the builder's own, or a provided PSU and LS/phones.